UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2008/2009 Academic Session
Peperiksaan Semester Kedua
Sidang Akademik 2008/2009

April/Mei 2009

ESA 382/3 – Spacecraft Sub-system Design
Rekabentuk Sub-sistem Kapal Angkasa

Duration : 3 hours
[Masa : 3 jam]

INSTRUCTION TO CANDIDATES
ARAHAN KEPADA CALON

Please ensure that this paper contains **SEVEN (7)** printed pages and **TEN (10)** questions before you begin examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **TUJUH (7)** mukasurat bercetak dan **SEPULUH (10)** soalan sebelum anda memulakan peperiksaan.*

Part A: Answer **ONE (1)** questions only.
Part B: Answer **ONE (1)** questions only.
Part C: Answer **FOUR (4)** questions only.
*Bahagian A: Jawab **SATU (1)** soalan sahaja.*
*Bahagian B: Jawab **SATU (1)** soalan sahaja.*
*Bahagian C: Jawab **EMPAT (4)** soalan sahaja.*

Student may answer the questions in English.
Pelajar boleh menjawab soalan dalam Bahasa Inggeris.

Each questions must begin from a new page.
Setiap soalan mestilah dimulakan pada mukasurat yang baru.

PART A/*BAHAGIAN A*

1. Give a brief description of the 8 major subsystems of a space vehicle and how they function.

   Berikan deskripsi bagi 8 subsistem utama sesebuah kenderaan angkasa dan bagaimana ia berfungsi.

   (20 marks/*markah*)

2. List 11 types of spacecraft power sources and briefly explain how each of them works.

   Senaraikan 11 jenis punca kuasa kapal angkasa dan terangkan bagaimana ia berfungsi.

   (20 marks/*markah*)

PART B/*BAHAGIAN B*

3. Size an array to support a 1700-W load plus battery charge.
Saizkan panel untuk menyokong sebuah pengecas bateri 1700-W.

Solar cell efficiency =11.5% at 28°C.
Kecekapan sel suria = 11.5% pada 28°C.

Operating temperature = 50°C.
Suhu operasi = 50°C.

Degradation over lifetime = 30% (10 years).
Pengurangan jangka hayat = 30% (10 tahun).

Sun angle (maximum off normal) = 8 degrees.
Sudut matahari (normal maksimum) = 8 darjah.

Solar intensity (1 A.U.) = 1350 W/m^2.
Kekuatan suria (1 A.U) = 1350 W/m^2

Temperature coefficient = -0.5% per °C.
Pekali suhu = -0.5% setiap °C.

Packing factor = 90% (10% area loss due to cell spacing).
Faktor penyendatan = 90% (10% kehilangan luas disebabkan penyendatan sel).

Battery capacity = 90 Ah.
Kapasiti bateri = 90 Ah.

For a 27.5-Volts battery array voltage = 27.5 × 1.2 = 33 Volts.
Bagi 27.5-Volts tatasusunan voltan bateri = 27.5 × 1.2 = 33 Volts.

For 2 cm × 4 cm cells - 8×10^{-4} m^2 per cell.
Bagi 2 cm × 4 cm sel - 8×10^{-4} m^2 setiap sel.

(20 marks/*markah*)

4. Explain briefly the SV heat-balance equation.

Terangkan dengan ringkas persamaan imbangan haba SV.

$Q_{sol} + Q_{ref.\ pl.} + Q_{em.\ pl} + Q_{aer} + Q_{int} - Q_{rad} = \Delta Q$ or

$$a_1 q_{sol} S_1 + a_1 q_{ref.\ pl} S_2 + a_2 q_{em.\ pl} S_2 + q_{aer} S_{mid} + W_{int} + kW_{pil} - \varepsilon\sigma T^4 S_{rad} = cM_{SV} \frac{\Delta T}{\Delta \tau}.$$

(20 marks/*markah*)

PART C/*BAHAGIAN C*

5. A satellite is in a Very High Earth Orbit. Size a Ni-Cd battery to support a 1800-W payload.

Sesebuah satelit berada pada orbit bumi tertinggi. Saizkan bateri Ni-Cd bagi menyokong beban bayar 1800W.

Bus voltage = 28 Volts direct current. Load duration = 1.1 hours maximum. Energy density = 15 Wh/lb for 100% discharge. Average cell voltage = 1.2 Volts. Maximum Depth of Discharge (DOD) is 70%.

Voltan bus = 28 Volts arus terus. Tempoh beban = 1.1 jam maksimum. Ketumpatan tenaga = 15 Wh/lb bagi 100% discaj. Purata voltan sel = 1.2 Volts. Maksimum discaj ukur dalam (DOD) adalah 70%.

(15 marks/*markah*)

6. Explain in detail a passive thermal control system and describe the mechanism of louvers, which are used as a passive thermal control system.

Terangkan dengan terperinci sistem kawalan haba pasif dan perihalkan mekanisma louvers, yang digunakan sebagai sistem kawalan haba pasif.

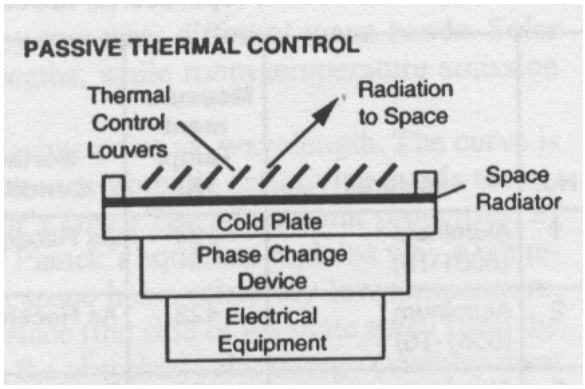

Figure 1/*Gambarajah 1*

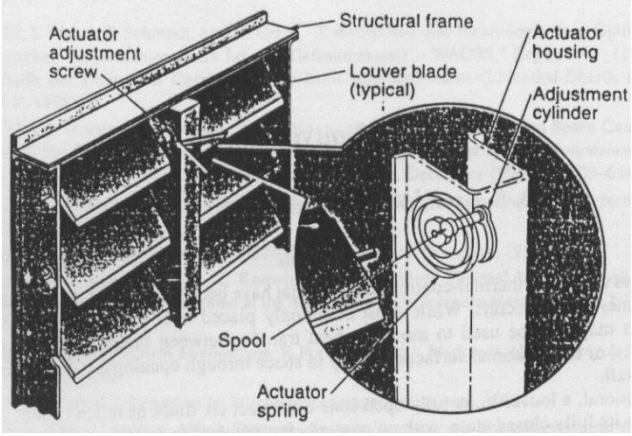

Figure 2/*Gambarajah 2*

(15 marks/*markah*)

7. Explain in detail an active thermal control system and describe and explain heaters as an example of an active thermal control system.

Terangkan dengan terperinci sesebuah sistem kawalan haba aktif dan perihalkan pemanas sebagai contoh sebuah sistem kawalan haba aktif.

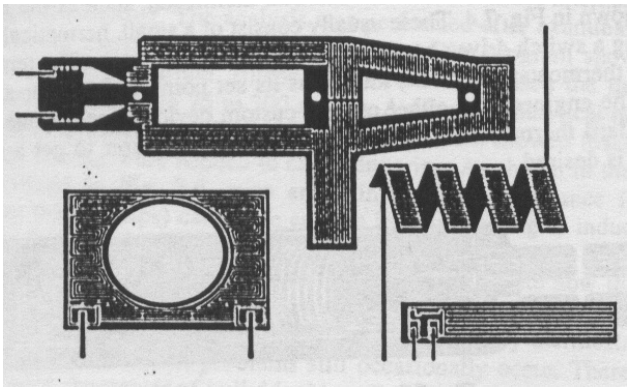

Figure 3/*Gambarajah 3*

(**15 marks/*markah*)**

8. Describe the functions of Command and Data Handling System

Perihalkan fungsi-fungsi Sistem Pengurusan Data dan Arahan.

(**15 marks/*markah***)

9. Describe the functions of Structures and Mechanisms subsystem.

Perihalkan fungsi-fungsi subsistem Struktur dan Mekanisma

(**15 marks/*markah***)

10. Structures and Mechanisms subsystem: Describe Structural Design requirements in a satellite.

Subsistem Struktur dan Mekanisma : Perihalkan keperluan rekabentuk struktur dalam sesesbuah satelit.

(**15 marks/*markah*)**

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